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THE STROMATOPOROIDS OF THE GUELPH FORMATION IN ONTARIO

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PREFATORY NOTE

The following article on the *Stromatoporoidea* of the Guelph dolomites is the first of a series of publications which it is proposed to issue on the Stromatoporoids of America. Palaeontologists have long felt the need of a revision of these forms, for most of the descriptions are contained in journals of early date which are more or less inaccessible. In many cases also the descriptions were written before the group was as well understood as it is at present, and, if illustrated at all, the figures are imperfect and on different scales of magnification. The most important means for the identification of species is a series of sections, vertical and tangential, on a uniform scale of magnification so that comparisons may be readily instituted. An attempt will be made to produce such a set of plates.

Since the appearance of Nicholson's monograph on the British Stromatoporoids we have an adequate and admirable basis on which to proceed with the classification of forms. The reader is referred to that volume for all generic descriptions, for a historical review of the subject and for a complete discussion of the anatomy of Stromatoporoids in general.

Owing to the incomplete preservation of many examples, the impossiblity of obtaining the type specimens, and the insufficiency of collections, numerous errors will occur and, in time, be detected, but I have proceeded on the principle that no better material may ever be found and that a provisional description is better than none.

My thanks are due to Dr. B. E. Walker, of Toronto, for advice, encouragement and the presentation of specimens, and to Professor J. M. Clarke, of Albany, for the loan of sections and other kindnesses.

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THE STROMATOPOROIDS OF THE GUELPH FORMATION IN ONTARIO

The Guelph dolomites typically exposed at Galt, Durham, Glenelg, Elora and a few other places in the western peninsula of Ontario are particularly rich in the remains of the puzzling and interesting group of the Stromatoporoids. The identification of these organisms is attended with peculiar difficulties, even in the case of well preserved material such as may be obtained from the Devonian rocks of Kelly's Island and numerous other points throughout the Corniferous and Hamilton exposures of Ontario and Ohio. In the case of the Guelph forms, added difficulty is encountered on account of the excessive crystallization and dolomitization which in the vast majority of cases have rendered the minute structure of the skeleton indeterminable or at least of very doubtful interpretation. Authors have persistently avoided the description of these forms on account of the difficulty of rigidly defining the species. The examination of a large number of specimens has led me to believe that the different species may be identified with reasonable certainty, although it may be impossible to frame a thoroughly scientific description of the minute structure. It is readily admitted that some of the following notes are based on poor material, but as it seems unlikely that any better will ever be discovered the attempt seems to be justified.

The amount of destruction wrought in these delicate skeletons by the forces of mineralization vary greatly, being least in some specimens of *Stromatopora*, and greatest in the examples of the genus *Labechia*. The different types of alteration may be considered under the following heads :—

(a) *Interstitial crystallization*—While the skeleton fibre is but little altered in some examples, it is found that the interspaces between the laminae and pillars are filled with

large crystals to such an extent as to displace the elements of the skeleton. Examined with a lens the surface of such specimens appears to be made up of a continuous mass of crystals with no appearance of organized structure whatever. Thin sections however reveal in a general way the character of the reticulation, but the minute structure of the skeleton fibre is not determinable.

(b) *Complete crystallization*—In this class of specimens the crystallization has invaded the fibre itself. The minute structure may be absolutely lost or may be apparent only by slight differences in colour. The surface resembles that of the type described above. Thin sections are quite useless, as the slight colour differences are not at all perceptible under the microscope. The only means of dealing with these specimens is to take advantage of polished surfaces on which the outline of the skeleton is sometimes shown by reason of a slightly greater density where the skeletal matter had existed.

(c) *Complete reversion* (Pl. II, Fig. 6; Pl. III, Figs. 1, 2, 5,6) —In many cases, particularly with examples of *Labechia*, the original skeleton has been surrounded by an infiltered matrix after which the fibre has been replaced by clear crystalline calcite ; the outline of the reticulation is therefore apparent in thin sections as clear interspaces while the true interlaminar cavities appear as darker spots. In some examples the original skeleton seems to have been surrounded by a thin layer of concretionary calcite or dolomite while the rest of the interlaminar cavities were filled by less dense and more crystalline matter. The true skeleton has then been replaced by calcite as described above. The visible result of this process is that on polished surfaces the cross section of a lamina appears as two delicate parallel lines while the pillars similarly cut present the appearance of rings. Thin sections show however that the concretionary calcite is sharply bounded towards the skeletal matter but that it fades gradually into

the substance filling the interlaminar cavities. Care is required in examining polished surfaces of this kind of specimen as the concretionary calcite presents much the same appearance as original skeletal fibre, so that there is a grave danger of interpreting pillars as tubes and single laminae as double (Plate II, Fig. 6).

(d) *Partial reversion*—Specimens are found in which the above process has not been uniformly performed throughout the coenosteum. These are so extremely difficult to interpret that they are best thrown aside.

(e) *Reversion and subsequent solution*—When specimens wholly or partly reversed have been subjected to the action of surface waters the secondary calcite occupying the place of the original skeleton is dissolved. Total disintegration may result or the solution may be only partial. This frequently happens in the case of reversed specimens of *Labechia* so that the position of the pillars is indicated by minute holes, presenting an appearance which has given rise to the name " Pin-hole fossils ". This condition is also often encountered in specimens of corals from the Guelph dolomite (Pl. VI, Fig. 1).

(f) One other peculiarity has been observed which is liable to give rise to erroneous conclusions. In several specimens the skeletal matter is seen to be surrounded at a little distance by a dark line which is separated from the skeleton by clear crystalline calcite. This line seems to be caused by a segregation of the colouring matter much in the same manner as the banded structure arises in mineral veins. In photographic reproductions of thin sections care must be taken to properly interpret this phenomenon (Pl. VI, Fig. 2).

Owing to the imperfect state of preservation it was found impossible properly to represent the anatomy by means of photo-micrographs. The accompanying plates have been reproduced from drawings which were made in the following way. Thin sections of varying thickness were prepared and

such of these as presented the most distinct outlines were photographed on a uniform magnification of ten diameters. A tracing was then made on drawing paper by placing the photographic print and paper before a strong light. It was found that by using a drawing paper of the proper density the outline of the skeleton appeared in greater perfection than in the photographic print itself as the less dense images of foreign particles and refraction lines were obscured. The detail of the drawing was then filled in partly by reference to the original thin section and partly by comparison with a polished surface of the specimen under review. Some of the figures are not continuous, i. e. they do not represent a continuous portion of the section but are made up from observations on different parts of the *same* surface. While these drawings may therefore lack the exactitude which can be obtained by direct photographic reproductions from good material they are infinitely better than the almost useless photographs which might be prepared from the badly preserved Stromatoporoids of the Guelph dolomite.

In the Report of Progress, Geol. Sur. Can., 1863, no mention is made of Stromatoporoids in the chapter on the Guelph formation. On reference to the Index of Reports 1863–1884, it is found that no account is given of the *Stromatoporidae* of the Guelph formation up to that date. The first reference to *Stromatopora* in this formation appears to have been made by Professor Nicholson in the Annals and Magazine of Natural History, Series 4, Vol. xii, 1873. A description with two figures is there given of *Stromatopora ostiolata*, Nich. (Pl. II, Figs. 1, 2). In the Report of the Palaeontology of Ontario, 1875, Professor Nicholson gives a lengthy account of *Stromatopora ostiolata* which at that time he was inclined to regard as a sponge. *Stromatopora concentrica*, Goldfuss, is also mentioned, but the author expresses doubt as to the identification of this species.

In the year 1867, Winchell (Proc. Am. Ass. Ad. Sci.) established the genus *Coenostroma*, which name was adopted by Sir J. W. Dawson in his description of a new species from the Guelph, *Coenostroma galtense*. (" Life's Dawn on the Earth," p. 160, 1875.) Reference to this species is also made by Dawson in the Quarterly Journal of the Geological Society, Vol. xxxv, p. 52, 1879. In the above mentioned article in the Quarterly Journal of the Geological Society Dawson deals at length with the question of the minute structure of Stromatoporoids and closes with a list of American species in which only two are mentioned from the Guelph, *Stromatopora ostiolata*, Nich., and *Coenostroma galtense*, Dawson. This latter species therefore replaces *Stromatopora concentrica*, Gold., in the opinion of the author. Dr. Whiteaves mentions no new Stromatoporoids in his article on Guelph fossils (Palaeozoic Fossils, Vol. III, Pt. i, Geol. Sur. Can., 1884). In Part ii of the above publication which appeared from the pen of the same author in 1895, the following list is given—

Clathrodictyon ostiolatum, Nich.
Clathrodictyon fastigiatum, Nich.
Labechia, Species undeterminable.
Stromatopora galtensis, Dawson.
Stromatopora antiqua, Nich. and Murie.
Stromatoporella, Species undeterminable.

These same species are given by Whiteaves in his list of Canadian Stromatoporoids in the Canadian Record of Science, 1896. Clarke and Ruedemann mention *Stromatopora galtensis*, Dawson, and *Clathrodictyon ostiolatum*, Nich. as occurring in the State of New York. (Guelph Fauna in the State of New York, N. Y. State Museum, Memoir 5, 1903.) Finally in Part iv, Vol. III of Palaeozoic Fossils, which has just appeared, Dr. Whiteaves repeats his former list of Guelph species. Two species only have therefore been recognized as characteristic of the Guelph while two others have been regarded as common to it and other Upper Silurian formations.

ORDER—STROMATOPOROIDEA, *Nicholson and Murie*
Section A. (Hydractinoid Group)

Family—ACTINOSTROMIDAE, *Nich.*
Genus—ACTINOSTROMA, *Nich. and Murie*

ACTINOSTROMA VULCANA, *sp. nov.* Plate I, Figures 1, 2, 5

Coenosteum massive, known only by fragments, composed of delicate curving horizontal laminae and continuous radial pillars. The laminae occur to the number of seven or eight in the space of one mm. The pillars are slightly stouter but are practically the same distance apart. The species is characterized by a most peculiar structure observed in one specimen only. Growing on what was at one time the surface of the coenosteum is a volcano-like prominence composed of laminae and pillars like the general skeletal matter but provided with a central, distinctly differentiated portion presenting an inverted cone-in-cone structure. A vertical section of this internal pipe shows it to have an almond-shaped outline with a rounded lower termination while the cone-in-cone arrangement of its constituent parts makes a cup-like depression at the top, at once suggesting a volcanic crater. The resemblance to a volcano is further emphasized by the arrangement of the laminae around the "pipe", for they appear exactly like a series of successive flows from a central vent (Pl. I, Fig. 5). This structure is eventually covered by the ordinary growth of the coenosteum. The whole elevation shows a height of ten mm. and a width of fifteen, while the "pipe" is five mm. high and two mm. wide.

Vertical sections of the coenosteum (Pl. I, Fig. 2) show it to be composed of well defined, delicate, horizontal laminae, seven or eight of which appear in the space of one mm. The laminae are connected by vertical pillars which are slightly stouter than the horizontal components but practically the same distance apart, so that the general appearance is that

of a square network, but certain of the squares are somewhat rounded as if by the presence of astrorhizal canals. The astrorhizal systems are delicate and appear to be superimposed, as a wall-less axial canal can be made out on parts of a vertical surface. The pillars are continuous and, in good sections, may be traced through as many as ten laminae.

Tangential sections (Pl. I, Fig. 1) exhibit the round ends of the radial pillars and very faintly, owing to imperfect preservation, the whorls of connecting arms typical of the genus *Actinostroma*. Astrorhizal canals are present but appear to be extremely delicate ; the sections are not sufficiently good to afford a full description of these structures.

The character of the skeletal matter is extremely like that of *Actinostroma stellulatum*, Nich. Although this species is European and Devonian, I should be inclined to place the present example under the same head were it not for the peculiar volcano-like structures above described, which, as far as I am aware, have not previously been observed in any Stromatoporoid.

From *Clathrodictyon ostiolatum* and from *C. striatellum* the species under review is distinguished by the more numerous laminae in a given space, seven or eight occurring in a mm. while only five occur in the Clathrodictyons. The continuity of the radial elements is of course convincing, but unless the section is strictly vertical mistakes may easily occur. Tangential sections show distinctly the much greater size of the cut ends of the radial pillars. At first I was much confused by the volcano-like structures, thinking them to be the cylinders of Nicholson's *C. ostiolatum.* However I am now convinced that they are not even analogous, for Nicholson's cylinders are composed of concentric laminae wound around the long axis, while the structures here described are quite different in the arrangement of the laminae. The species is founded on three fragments from Durham, Ont.

Genus—CLATHRODICTYON, *Nich. and Murie*

CLATHRODICTYON OSTIOLATUM, *Nich.*—Plate II, Figs. 1-2 ; Plate V, Figs. 7-8

STROMATOPORA OSTIOLATA, *Nich.*, An. and Mag. Nat. Hist., ser. 4, 12 : 90, pl. 5, fig. i a, 1873.
STROMATOPORA OSTIOLATA, *Nich.*, Palaeontology Prov. of Ontario, pl. i, fig. 1, 1a, 1874 ; p. 63, 1875.
CLATHRODICTYON OSTIOLATUM, *Nich.*, Monograph British Stromatoporoids, pt. i, p. 14, 1886.
CLATHRODICTYON OSTIOLATUM, *Nich.*, An. and Mag. Nat. Hist., ser. 5, 19 : 12, pl. 3, figs. 1-3, 1887.
CLATHRODICTYON OSTIOLATUM, *Whiteaves*, Palaeozoic Fossils, vol. iii, pt. 2, p. 52, 1895.
CLATHRODICTYON OSTIOLATUM, *Whiteaves*, Can. Rec. Sci., vol. vii, No. 3, 1896.
CLATHRODICTYUM OSTIOLATUM, *Clarke and Ruedemann*, Guelph Fauna State of New York, N. Y. State Museum Memoir 5, p. 37, pl. 1, figs. 10-12, 1903.
CLATHRODICTYON OSTIOLATUM, *Whiteaves*, Palaeozoic Fossils, vol. iii, pt. iv, p. 328, 1906.

Nicholson's description of this very remarkable form is in part as follows :—" Fossil forming large hemispherical masses, several inches in diameter, composed of innumerable delicate laminae, arranged concentrically, and separated by interspaces which are broken up by numerous slender vertical pillars, giving the whole a finely reticulate structure. The laminae are as thin as writing paper ; and, with the intervening interspaces, there are about ten of them in the space of one line. The upper surface of the mass is undulated and is quite smooth, except for the presence of rounded or conical elevations, perforated at the apex with rounded openings, and arranged with tolerable regularity in diagonal lines. These elevations have a width of half a line and appear to be of the nature of exhalent apertures or oscula........Laterally the laminae and osculiferous surfaces instead of being concentrically arranged as regards the entire mass, terminate in a series of rounded, nipple-shaped prominences, each of which is composed of thin concentric laminae which scale off like the coats of an onion. ....In the present species, intercalated among the general enveloping concentric laminae of the mass

is a series of cylindrical masses, each composed of laminae concentric with its long axis, and each terminating (probably at both ends though this is not shown) in a rounded nipple-shaped extremity. Superiorly these laminated cylinders are enveloped by laminae concentric to the whole mass, so that the outermost surface is simply undulating." (Pl. II, Fig. 1.)

Nicholson's amended description as contained in the Annals and Magazine of Natural History, 1887, is in part as follows :—" Coenosteum massive, composed of concentrically laminated parallel cylinders, which are more or less enveloped by laminae concentric with the entire colony, and which terminate superficially in blunt nipple-shaped prominences. Under surface unknown. Surface of the laminae smooth or with exceedingly fine granulations, without tubercles or mamelons. Astrorhizae well developed, each system having a vertical, wall-less axial canal, which opens on the surface of the laminae by a slightly projecting round aperture. As regards internal structure, the skeleton is composed of exceedingly delicate laminae, about five of which occupy the space of 1 millim. The laminae are curved in conformity with the curvature of the fossil, and are not at all, or but slightly, inflected or crumpled. Each lamina gives off downwards numerous close-set and delicate radial pillars, which may or may not reach the lamina below. The interlaminar cells are thus more or less quadrangular in shape, though often incomplete." (Pl. II, Fig. 2.)

Nicholson's description of the skeletal matter of *C. ostiolatum* conforms very closely to that given for *C. striatellum*. Both species have five very delicate laminae to the mm. and in both some of the pillars fail to reach the next lamina. It would appear that the laminae are less crumpled in *C. ostiolatum*, but this feature is very difficult to determine. Further, although not mentioned in the text, Nicholson's figure of *C. ostiolatum* shows the double-based pillars given for *C.*

striatellum. It seems highly probable that the species *C. ostiolatum* would not have been founded on the minute structure of the skeleton alone, it must therefore depend for its existence on the presence of the characteristic cylinders and their nipple-like projections. Most of the specimens which, from a study of their minute structure, might be ascribed to either species do not show the cylinders even over vertical sections as large as eight inches by four inches. It seems justifiable therefore to conclude that both species are present and to restrict the name *C. ostiolatum* to those specimens which show distinct evidence of being composed of a series of parallel cylinders enveloped in the general tissue of the coenosteum. It should also be noted that, according to Nicholson, astrorhizal systems are well developed in *C. ostiolatum* but absent in *C. striatellum.*

The type specimen of *C. ostiolatum* is probably lost, for Nicholson states that it was the property of the University of Toronto. The disastrous fire of 1890, which injured the University museum, must therefore have destroyed this type together with other valuable material. Besides specimens from different localities in the Guelph the museum contains a specimen from the Upper Niagara near Hamilton, Ont., which apparently belongs to this species.

CLATHRODICTYON STRIATELLUM, *D'Orb.* Plate I, Figs. 3-4 ; Plate VI, Fig. 8

STROMATOPORA CONCENTRICA, *Lonsdale,* Silurian System, p. 680, pl. xv, fig. 31, 1839.
STROMATOPORA STRIATELLA, *D'Orbigny,* Prodrome de Paléontologie, t. i, p. 51, 1850.
STROMATOPORA MAMMILLATA, *Fr. Schmidt,* Sil. Form. von Ehstland. p. 232, 1858.
STROMATOPORA MAMMILLATA, *von Rosen,* Ueber die Natur der Stromatoporen, p. 71, pl. viii, figs. 1-5, 1867.
STROMATOPORA MAMMILLATA, *Ferd. Roemer,* Lethaea Palaeozoica, part i, p. 531, fig. 125, 1883.
CLATHRODICTYON STRIATELLUM, *Nicholson,* Ann. Nat. Hist., ser. 5, vol. xix, p. 6, pl. 1, figs. 9 and 10, 1887.
CLATHRODICTYON STRIATELLUM, *Nicholson,* Mon. British Stromatoporoids, p. 156, pl. 1, fig. 1 ; pl. v, fig. 3, pl. xix, figs. 6-12.

Nicholson's description in the last article cited above is as follows :—" The coenosteum in this species is mostly laminar or hemispherical with a concentrically wrinkled epitheca. The surface is more or less undulated, but without definite eminences or " mamelons ", the concentric laminae usually exfoliating concentrically round elevated points. Astrorhizae are apparently wanting.

" As regards internal structure, vertical sections (Pl. I, Fig. 4) show that the concentric laminae are comparatively remote, about four interlaminar spaces, and therefore five laminae, occupying the space of 1 mm.; but the interlaminar spaces are wider over the convexities of the undulated laminae. The concentric laminae are thrown into successive undulations, which are more pronounced in some specimens than in others, but are always gentle and regularly curved. The laminae are also regularly crumpled in the same manner as in *C. vesiculosum*, but less completely, so that there is no appearance in vertical sections of rows of lenticular vesicles, such as are so characteristic of the latter species. Each infolding of the lamina is, however, prolonged downwards into the interlaminar space below in the form of a more or less complete radial pillar. Some of the radial pillars are quite short, others project about half-way into the interlaminar space ; others cross the space and become connected with the lamina below ; finally, a few spring from the upper sides of the laminae. A further very characteristic point about the radial pillars is that they are very commonly double at their bases, where they spring from their producing lamina.

" Tangental sections (Pl. I, Fig. 3 ; Pt. VI, Fig. 8) of this species are much more characteristic than is usual in the genus *Clathrodictyon*. Where such a section traverses an interlaminar space, the cut ends of the radial pillars are seen in the form of dark granular masses, of considerable size, and usually of a more or less elongated or oval shape. Where

the section more or less closely coincides with a concentric lamina, the cut ends of the radial pillars are more closely set and larger in size, and often form a sort of mosaic pavement, or at other times a loose reticulation. Tangential sections are also unlike similar sections of most species of this genus in the apparent absence of astrorhizal canals.

" *Obs.*—In its general features *Clathrodictyon striatellum* can hardly be confounded with any other member of the genus. In external and superficial characters it makes a close approach to *C. regulare*, Rosen, but its size is usually much greater, its general texture is coarser, and its internal structure is quite different. Its most distinctive characters are the gentle and regular undulation of the concentric laminae, and the peculiar form of the radial pillars which spring, very commonly by a double base, from the under sides of the laminae, and often fall short of the upper surface of the lamina next below. The exposed surfaces of the concentric laminae in well preserved examples show, much more clearly than is usual in the genus, the presence of innumerable zooidal pores. The radial pillars produce no connecting processes or " arms "; whereas these structures are occasionally developed in *C. regulare*. Lastly, the present form shows a more complete absence of the astrorhizal system, so far as my observation goes, than is the case in any related form of *Clathrodictyon*.

" My identification of this form as the one which D'Orbigny had in view in establishing his *Stromatopora striatella* is based upon an examination of Lonsdale's original specimen, which served as the type of the species to the French palaeontologist, and which is now in the British Museum. My identification of *Stromatopora mammillata*, Fr. Schmidt, with D'Orbigny's species, is based upon specimens of the former kindly given me by Magister Schmidt himself. I have figured a portion of the surface, and also tangential and vertical sections of one of these specimens. These will show that there

exists no substantial difference between the Russian and the British specimens, which I have here included in the present species. Any apparent differences which are present may probably be accounted for by the fact that the Esthonian specimens are silicified, and have therefore undergone considerable alteration.

" *Distribution.—Clathrodictyon striatellum*, D'Orbigny, occurs in the Ordovician rocks of Esthonia (in the " Borkholm'sche Schichten "); but elsewhere it is only known as a Silurian species. It is common in the Wenlock Limestone of Britain (Dudley, Ironbridge, Dormington, &c.), and it is also found in the Wenlock Limestone of Wisby, Gotland."

It should also be noted that Nicholson was originally of the opinion that *C. striatellum* occurred in the Niagara for he mentions the species in the report on the Palaeontology of Ontario as being common in the Niagara at Thorold and rare at Rockwood. Later he seems to have altered his opinion for it is not mentioned in his monograph. I am forced to the conclusion that many examples hitherto ascribed to *C. ostiolatum* belong properly to this species. The skeletal fibre is remarkably similar, so much so, that it is impossible to make a distinction. The main difference seems to be that the laminae in *C. striatellum* are more crumpled than in the other species. With such material as we have it is impossible to make this distinction ; furthermore some specimens from the European localities are not more crumpled than undoubted examples of *C. ostiolatum.* Nicholson himself admits that considerable variation occurs in this respect. However the crucial test is the presence of the " cylinders ". Without these structures it seems impossible to ascribe a specimen to *C. ostiolatum.* Many of the specimens examined are entirely without this typical arrangement of the laminae ; these are not parts only, but large pieces, four inches by eight. Further, large specimens of perfect hemispherical shape show

nothing but the regularly curved laminae thoughout the whole coenosteum. The most serious difficulty in the identification of *C. striatellum* in the Guelph is the fact that Nicholson states that astrorhizal systems are absent, while in the Guelph examples they appear to be present. However only one system was observed in a considerable number of sections, so that it is reasonable to suppose they were overlooked by Nicholson. If my conclusions are correct, *C. striatellum* is much more abundant than *C. ostiolatum* and occurs at all the typical localities.

CLATHRODICTYON FASTIGIATUM, *Nich.*—Plate I, Fig. 6

CLATHRODICTYON FASTIGIATUM, *Nicholson*, Mon. Brit. Strom., pt. 11, p. 43, fig. 3, 1886.
CLATHRODICTYON FASTIGIATUM, *Nicholson*, Ann. Nat. Hist., ser. 5, vol. xix, p. 8, pl. 2, figs. 3 and 4, 1887.
CLATHRODICTYON FASTIGIATUM, *Nicholson*, Mon. Brit. Stromatop., pt. 2, p. 152, pl. 19, figs. 1-5, 1888.
CLATHRODICTYON FASTIGIATUM, *Whiteaves*, Pal. Fossils, vol. iii, pt. ii, p. 52, 1895.
CLATHRODICTYON FASTIGIATUM, *Whiteaves*, Can. Rec. Sci., vol. vii, No. 3, p. 135, 1896.
CLATHRODICTYON FASTIGIATUM, *Whiteaves*, Pal. Fossils, vol. iii, pt. iv, p. 328, 1906.

Nicholson's description of the above species as given in his monograph (op. cit.) is as follows :—

"The coenosteum in this species is laminar and cake-like, of variable size, but of small thickness, full-grown examples having a diameter of 15 cm. or more, with a thickness in the centre of from 2 to 3 cm. The under surface is covered with a concentrically wrinkled epitheca. The superior side of the coenosteum is flat, or slightly undulated, but is quite free from " mamelons " The surface exhibits, when well preserved, numerous vermiculate and inosculating ridges formed by rows of elongated tubercles. Small and remote astrorhizae may sometimes be recognized in thin section but their development is imperfect, and I have not detected their presence on the free surface.

"As regards its internal structu e, the coenosteum is composed of bent and crumpled concentric laminae, of which about five (or four interlaminar spaces) usually occupy the space of 1 mm. As shown by vertical sections (Pl. I, Fig. 6) the laminae are bent in two ways. n the first place they are bent into numerous chevron-like foldings, no traces of which appear on the surface of the coenosteum. In the second place each lamina is minutely crumpled or inflected in such a way that the interlaminar spaces are constricted into rows of very imperfect and more or less open vesicles. The radial pillars are developed from the point of inflection of the laminae, but are thin and largely imperfect. Hence, in vertical sections, the bent and crumpled laminae are far more conspicuous than the radial pillars. Tangential sections exhibit the irregularly sinuous and vermiculate edges of the transversely divided and folded laminae, the cut ends of the radial pillars appearing in these as dark rounded dots. Occasionally we may also recognize in tangential sections scattered points round which rows of dots are disposed in a radiating manner. Such points represent the centres of small astrorhizae.

"*Obs.*—*C. fastigiatum* has certain relationships with *C. variolare*, Rosen sp., and specimens occasionally occur which present a mixture of the characters of the two forms. In typical examples, however, the present beautiful species cannot readily be confounded with any other known member of the genus *Clathrodictyon*. It is distinguished from its nearest allies (viz. *C. vari lare*, Rosen, nd *C. vesiculosum*, Nich. and Mur.) by the greater remoteness of the concentric laminae, and by the peculiar and constant chevron-like and angular folds into which the laminae are thrown. The appearances presented by tangential sections are also exceedingly characteristic, and quite unlike those seen in any other species of *Clathrodic yon* wit h which I am acquainted. The very imperfect development of the astrorhizae is also a point in which the

present species is separated from the forms above alluded to. Lastly, as far as I have seen, the coenosteum of *C. fastigiatum* always has the form of a thin, cake-like expansion, with a concentrically wrinkled epitheca below.

" *Distribution.—C. fastigiatum* occurs abundantly in the Wenlock Limestone of Britain, and I have specimens of it from Ironbridge, Dudley, Much Wenlock, and Dormington. I have also collected examples of this species in the Silurian (" zone of *Pentamerus esthonus* ") of Kattentack, Esthonia. By the kindness of Mr. Whiteaves, I have have also been enabled to examine specimens of this species belonging to the collection of the Geological Survey of Canada. The specimens in question are from Glenelg Township, near Durham, Ontario, and occur in a Magnesian Limestone belonging to the Guelph formation."

To this description there is nothing to be added. The species is well marked and easily identified. The University Museum possesses specimens from Elora and from Aboyne as well as from the Township of Glenelg.

Family—LABECHIIDAE, *Nicholson*

Genus—LABECHIA, *Edwards and Haime*

LABECHIA DURHAMENSIS, *sp. nov.* Plate II, Figs. 4-6 ; Plate VI, Figs. 1, 2

Coenosteum massive, growing from a finely wrinkled concave epitheca, and reaching a width of a foot or more. Extreme thickness not observed, but cannot be less than eight or ten inches. Mode of growth distinctly latilaminar, the layers having an average thickness of five mm.

The vertical elements are well marked pillars of large size which appear to have been hollow. The average width of a pillar is ¼ mm. and the average interspace ½ mm., but considerable variation is to be observed. The pillars are

connected by horizontal bars at irregular intervals, from eight to ten occurring in the distance of four mm.

Tangential sections (Plate II, Fig. 5 ; Pl. VI, Fig. 2) present a series of rounded dots representing the cut ends of the pillars. Occasionally the pillars are seen to be connected by bars in the manner typical of the genus *Labechia*. The hollow character of the pillars is seen only in exceptionally well preserved examples.

Vertical sections (Plate II, Fig. 4) exhibit the continuous pillars and the connecting bars ; those cut transversely appearing as irregular dots while those which happen to follow the plane of the section are seen as flexuous lines of some thickness passing from pillar to pillar.

This is a well marked species and capable of easy identification, when occurring under ordinary conditions. However the great majority of examples are in the " reversed " state. In these the substance of the original skeleton has been surrounded by infiltered matter and the fibre subsequently replaced by crystalline calcite. The fossil therefore appears in section as clear white matter traversing a muddy base. In many examples this calcite has subsequently been dissolved so that the specimen shows a mass of rock penetrated by numerous small holes. This peculiarity has given rise to the popular term " pin-hole fossils ". (Pl. VI, Fig. 1.)

Tangential sections of the reversed examples (Pl. II, Fig. 6) show the cross sections of these pin-holes which are seen to be connected by clear spaces corresponding to the original position of the bars. A rather puzzling appearance is sometimes shown by these specimens ; the infiltered calcite and dolomite seems to have formed a concretionary layer around the original skeleton, so that, in thin sections and on polished surfaces, a dense line is seen to surround the position of the pillars. First inspection is apt to lead to the conclusion that these lines represent actual organic tissue but I believe the explanation to be as indicated above. (Pl. II, Fig. 6.)

Vertical sections of the reversed specimens (Pl. III, Fig. 1) show no new features. The peculiar appearance due to the method of mineralization above described is to be seen on the face of most polished specimens.

From *Labechia conferta*, Lons., the present species differs in the smaller size and more remote position of the pillars and in the coarser character of the connecting bars. From *L. canadensis*, Nich., it differs in the much finer nature of the whole coenosteum. *Labechia durhamensis* occurs in abundance, particularly in the reversed condition, at Durham, Galt, Guelph, Elora and throughout the Guelph of Ontario.

LABECHIA MINORA, *sp. nov.* Plate III, Figs. 2, 5, 6

Coenosteum large, spreading, gently undulating, reaching a width of at least two feet. Thickness unknown but must have been considerable, perhaps ten inches or a foot. Coenosteum composed of distinct latilaminae varying from four to eight mm. in thickness. The only specimens known are in the reversed condition so that no information is available regarding the surface condition of the species.

The coenosteum appears to have been composed of well marked vertical pillars and flexuous connecting bars. The size of these pillars cannot be stated with accuracy but they seem to vary from one-tenth to one-fifth of one mm. in diameter. The space between the pillars is likewise not to be stated with certainty as considerable variation was observed. This uncertainty however is doubtless to be attributed to the poor state of preservation rather than to an organic difference in the distribution of the pillars.

Vertical sections (Pl. III, Fig. 2) show the clear calcite filling the cavities left by the solution of the pillars and their connecting arms.

Tangential sections (Pl. III, Figs. 5, 6) show the cut ends of the pillars as clear spaces, here and there connected by oc-

casional openings. The two figures exhibit a considerable difference in the distance apart of the pillars but this is to be attributed to a more perfect preservation in the one case.

L. minora is distinctly finer than *L. durhamensis* and it is impossible to confuse the two species. The reversed specimens of both species present somewhat the same appearance as to their " pin-hole " character, but the larger size of the pores in the *L. durhamensis* is at once apparent. A normal example of *L. minora* has not been examined ; all the available specimens being reversed. In this state however the species is common and occurs in large masses at Elora, Galt, Durham, Glenroading, etc.

Genus—ROSENELLA, *Nich.*

ROSENELLA GLENELGENSIS, *sp. nov.* Plate II, Fig. 3 ; Plate III, Fig. 4 ; Plate VI, Fig. 5

Coenosteum consisting of a series of flat or undulating plates of considerable thickness enclosing large lenticular interspaces. The plates are separated from each other in a vertical direction by an average interspace of one mm. Their undulations however bring them in contact in a horizontal direction at distances varying from almost nothing to as much as 50 mm. Occasionally also contiguous plates are connected by a single vertical bar or tube. The surface of each layer is minutely ridged and tuberculated and provided with a rich system of astrorhizal canals. Occasional large pores penetrate the laminae. These seem to have no distinct distribution, as in some cases they correspond with the astrorhizal centres and in other cases are quite distinct. The plates vary somewhat in thickness but average about one-quarter to one-fifth of one mm. (Pl. III, Fig. 4.)

Vertical sections (Pl. II, Fig. 3) show the cut edges of the horizontal plates as a series of undulating lines with lenticular masses of matrix between. The upper surface of the plates,

in many instances, shows a dense border line, which however can, in other cases, be seen on both sides of the lamina. An occasional plate shows this dense line towards the centre. Very fine and indistinct striations cross the plates in a vertical direction. Although no certain evidence is obtainable, these striations probably represent minute tubuli. The large pores already referred to can be seen as distinct openings in the laminae as viewed in cross section.

Tangential sections are very unsatisfactory, and in fact reveal nothing further as to the minute structure of the species. The surface of each plate is marked by numerous little rounded and ridge-like elevations between which run the horizontal canals of fine but distinct astrorhizal systems. (Pl. VI, Fig. 5.) The centres of these systems are about 10 mm. apart and are usually situated in a depression of the plate. The large central canal is well marked in some examples, but in others is apparently absent. I am inclined to regard the large open axial canal of the astrorhizal systems as normal and to ascribe its absence to the process of mineralization.

Many examples of this species have been labelled *Stromatopora antiqua* but I cannot agree with this identification. If we have to deal with a *Stromatopora* the horizontal plates must represent latilaminae. But latilaminae are essentially distinct from each other which is not the case here. The plates are also separated from each other by too great an interval for this explanation to hold good. It may be urged that the original latilaminae were thicker and have been reduced by solution. Such a process could not produce the regularity of separation of the plates nor would it leave the surface in the excellent condition observed. The fibre of the coenosteum is dense and not at all of the porous character typical of the Milleporoid type of Stromatoporoid.

The open lenticular skeleton and the absence of pillars at once suggests Nicholson's genus *Rosenella*, but it must be

admitted that differences exist, particularly in the presence of astrorhizal systems and the absence of even rudiments of pillars. *Rosenella glenelgensis* occurs in some abundance at Durham and Elora.

Section B. (Milleporoid Group.)
Family—STROMATOPORIDAE, *Nicholson*
Genus—STROMATOPORA, *Goldfuss*

STROMATOPORA GALTENSIS, *Dawson.* Plate IV, Figs. 3-4

COENOSTROMA GALTENSE, *Dawson*, Life's Dawn on the Earth, p. 160, 1875.
COENOSTROMA GALTENSE, *Dawson*, Quart. Jour. Geol. Soc. Lond., vol. xxv, p. 52, 1879.
Cf. STROMATOPORA CONSTELLATA, *Hall*, Palaeontol. New York, 3: 324, 1852.
STROMATOPORA GALTENSIS, *Nicholson*, Mon. Brit. Strom., p. 173, 1891.
STROMATOPORA GALTENSIS, *Whiteaves*, Pal. Fossils, vol. iii, p. 52, 1895.
STROMATOPORA GALTENSIS, *Whiteaves*, Can. Rec. Sci., vol. vii, p. 136, 1896.
STROMATOPORA GALTENSIS, *Clarke and Ruedemann*, N. Y. State Museum, Memoir 5, p. 36, pl. i, fig. 13, 1903.
STROMATOPORA GALTENSIS, *Whiteaves*, Pal. Fossils, vol. iii, p. 328, 1906.

Sir William Dawson's description of this species was made at a time when the nature of *Stromatopora* was but little understood; in consequence it is impossible to recognize the species from any description yet published. In his monograph Professor Nicholson refers to a specimen examined by him and states that the minute structure is much destroyed by mineralization but that the species is closely allied or identical with *S. typica*, von Rosen. Nicholson is also of the opinion that both these species are probably identical with *S. constellata*, Hall. With the view of attempting to clear up this difficulty I have endeavoured to obtain a view of Dawson's type but have been unsuccessful. Professor Clarke of the New York State Geological Survey has kindly furnished me with sections of *S. constellata* from the Cobleskill and Dr. B. E. Walker has presented to the museum a specimen of *S. typica* from the Wenlock limestone of England which had been identified by Nicholson.

In the Guelph collection examined there are two species of true *Stromatopora* (omitting *S. antiqua*) and one or two of

Stromatoporella. On ordinary inspection the *Stromatoporella* might easily be mistaken for *Stromatopora* and as far as Dawson's description goes might serve as an example of his *S. galtensis.* Nicholson however has stated that the specimen examined by him resembles *S. typica* therefore we must conclude that one of the *Stromatopora* represents the species. The one most closely resembling *S. typica* is much finer in grain than the other and is made the basis for the description here given. Without an opportunity to inspect the type I can not positively state that we are dealing with a true example of the species described by Dawson.

Coenosteum massive, concentric. Neither upper nor under surface observed with certainty. Latilaminar structure but faintly indicated. Skeletal matter minutely fibrous. Pillars and laminae completely fused. The coenosteal tissue is pierced by numerous, slightly flexuous, tabulate zooidal tubes which are about one-eighth of a millimetre in diameter. The tabulae are numerous and distinctly preserved; as many as ten appearing in the space of one mm. The interspaces between neighbouring tubes are about one and one-half times as wide as the tubes themselves. Astrorhizal systems are well developed and are superimposed, being centred by a continuous wall-less axial canal. The systems average 6 mm. apart.

Vertical sections exhibit the inosculating fibre of the tissue, the zooidal tubes, the cut ends of astrorhizal canals and an occasional vacuity in the skeletal matter which is however fairly dense. (Pl. IV, Fig. 3.)

Tangential sections show the cut ends of zooidal tubes, vacuities in the tissue and the astrorhizal canals. (Pl. IV, Fig. 4.) These various features are typical of true *Stromatopora*; specific differentiation is largely a matter of fineness of grain and the character of the zooidal tubes.

In my opinion the present example more closely resembles *S. concentrica* than *S. typica.* It is certainly not the latter,

but in view of the fact that *S. concentrica* is said by Nicholson to be confined to the Devonian and not to occur in America I hesitate to place our species under that name. From *S. typica* the species is easily differentiated by the much coarser character of the tubes and the connecting tissue. In vertical sections six tubes and their interspaces occupy the distance of two mm. The same dimensions are given by Nicholson for *S. concentrica.* In my specimen of *S. typica* nine or ten tubes occur in the same distance. Although not so apparent on limited sections, a wide view of a vertical surface shows that the tubes of *S. typica* are much more nearly parallel than in this example. Tangential sections exhibit a closeness and coarseness of fibre much more like *S. concentrica* than *S. typica.* In fact the differences of our species from *S. concentrica* are hard to find, the only point observed being that the tabulae of the zooidal tubes are a little closer together. A comparison of the figures here given of *S. typica* and *S. constellata* prove the identity of these forms. As they are not found in the Guelph no description is given. (Plate IV, Figs. 5-8.)

If *S. galtensis* is not considered to be identical with *S. concentrica* it must be placed very near it and may be regarded as the American type of that species. There can be little doubt that it represents the Guelph development of the Niagaran *S. typica.* Specimens of *S. galtensis* are among the rarest of the Guelph Stromatoporoids, but in this museum, and I have no doubt in many others, numerous examples of a species to be described as *Stromatoporella elora* have been ascribed to *S. galtensis.*

Dawson's type appears to have been lost. Dr. Whiteaves assures me it is not now in the collection of the Geological Survey and Dr. Adams makes the same statement for the Redpath museum at Montreal. It is very unfortunate that this should be the case, and I must disclaim any responsibility for the identification here given. Dawson's specimen

was obtained at Galt ; the Geological Survey had, at one time, a specimen from Hespeler. The specimens on which the present description is based are from Elora and Durham.

STROMATOPORA ANTIQUA, *Nicholson and Murie*

PACHYSTROMA ANTIQUA, *Nich. and Murie*, Jour. Linn. Soc., vol. xiv, p. 224, pl. 4, figs. 2-5, 1879.
STROMATOPORA ANTIQUA, *Nicholson*, Mon. Brit. Strom., pt. I, p. 17, pl. 5, figs. 8-11, 1886.
STROMATOPORA ANTIQUA, *Nicholson*, Ann. and Mag. Nat. Hist., p. 310, pl. viii-x, April, 1891.
STROMATOPORA ANTIQUA, *Whiteaves*, Pal. Fossils, vol. iii, pt. ii, p. 53, 1895
STROMATOPORA ANTIQUA, *Whiteaves*, Can. Rec. Sci., vol. vii, No. 3, p. 136, July, 1896.
STROMATOPORA ANTIQUA, *Whiteaves*, Pal. Fossils, vol. iii, pt. iv, p. 328, 1906.

Stromatopora antiqua is a Niagara species of very doubtful occurrence in the Guelph. A careful examination of a large number of specimens which might provisionally be placed here has resulted in no certain identification of the species. Many large hemispherical Stromatoporoids occur, which in the general shape of the coenosteum and in the distinct latilaminar structure conform to the description of *S. antiqua*. In every instance the minute structure is entirely destroyed. Professor Nicholson states (Ann. and Mag. Nat. Hist., op. cit.) "A poorly preserved specimen in dolomitic limestone of Niagara age from Durham, Ont., may also *possibly belong to this species.*" A description of *S. antiqua* will be deferred until the Niagara forms are revised.

STROMATOPORA, *sp. indet.*

There is no doubt that a species of true *Stromatopora* differing from *S. galtensis* or *S. antiqua* is present but the preservation is so poor that it would be rash to attempt a description. The coenosteum seems to be composed of coarsely porous fibre through which run large open canals. No attempt to obtain sections was at all satisfactory, for, although cuts were made in numerous directions it seemed impossible

to locate either a tangential or vertical slice. The general structure is very much coarser than in *S. galtensis* or in *S. concentrica*, but whether the curving, open canals represent astrorhizal systems or zooidal tubes I am unable to say.

Genus—STROMATOPORELLA, *Nicholson*

STROMATOPORELLA ELORA, *sp. nov.* Plate III, Fig. 3; Plate V, Figs. 1, 3, 4; Plate VI, Fig. 6

Coenosteum massive, apparently concentric and hemispherical. Latilaminar structure present but not pronounced except in weathered specimens. Latilaminae about 4 mm. thick. Both pillars and horizontal elements are distinct but are imperfectly fused in the manner described by Nicholson for the genus. Skeletal fibre minutely porous as in the genus *Stromatopora*. Fairly long zooidal tubes penetrate the coenosteum vertically. No very certain evidence of tabulae in the tubes has been observed, but it is extremely likely that they existed. Astrorhizal systems are well developed the centres being from 3 to 6 mm. apart. A very large axial canal forms the centre of the system and this canal is surrounded by a stout " astrorhizal cylinder " in which a vertical arrangement of the tissue is perceptible as well as a faintly defined central line. The astrorhizal canals are large, round and strictly superimposed, at least in some cases, as six or eight of the cut ends may be observed lying one above the other between the same pair of vertical pillars. About five horizontal laminae with the intervening interspaces occur in one mm., but in certain parts of a latilamina they are somewhat more closely crowded. The pillars are, on the whole, more distinct than the laminae but some sections were observed where the opposite was true. Four to five pillars occur in the space of one mm.

A considerable number of vertical sections were prepared which present a puzzling difference and cause great trouble

in photographing. Badly preserved at the best, so that thin sections are difficult to examine, this species seems to have a peculiar power to absorb Canada balsam with the result that the evidence of structure entirely disappears. The best results were obtained by photographing the polished surface.

The average vertical section presents the appearance seen in Pl. V, Fig. 1. The vertical pillars are apparent as well as the horizontal laminae. Zooidal tubes are but indistinctly seen. A much better preserved portion is seen in Pl. III, Fig. 3, which was prepared from a polished surface. The horizontal laminae and the vertical pillars are here quite distinct as well as the zooidal tubes, which owing to mineralization show but faint evidence of tabulae. The wide open axial canal of the astrorhizal system is well shown with a heavy cylinder surrounding it. This cylinder shows indistinct vertical striations and some evidence of a central hollow. Certain sections show the large axial canals lying one above another between a pair of pillars. Occasional sections are cut which show scarcely any sign of the laminae. Such slices suggest the structure of a true *Stromatopora.*

Tangential sections are, on the whole, more satisfactory than the vertical. The coarsely porous character of the fibre is distinctly seen. The cut ends of the wide axial tubes are prominent, as well as the ramifying canals of the astrorhizae A somewhat different appearance is presented according to the level at which the section is cut. If the line of section passes through a lamina (Pl.V, Fig. 3) the astrorhizal canals are conspicuous and the pillars lose their significance, being fused together by the horizontal elements. Through the tissue thus formed pass the distinct round zooidal tubes. In many parts of such sections the pillars are seen to be deformed by the zooidal tubes pointing to the assumption that the latter are the more important elements to which the pillars have to give place. If the horizontal section is situated at

the level of an interlaminar space (Pl. V, Fig. 4) the tissue is less continuous and presents a ring-like appearance. These rings are not proper tube walls but are made up of two or more pillars which are deformed and united into a ring surrounding the zooidal tube. In some cases they are contiguous so that the section appears as series of coalesced circles. Occasionally very delicate lines can be made out connecting the pillars as in *Actinostroma* but in the majority of cases they are united by their own deformation as described above.

It is apparent from this description that we have to deal with a form intermediate between *Stromatopora* and *Actinostroma*. The minute structure of the fibre is distinctly of the character ascribed to the Milleporoid group, while the incomplete fusion of the vertical and horizontal elements as well as some sign of delicate connecting arms points to a relationship with the genus *Actinostroma*. Nicholson's genus *Stromatoporella* approaches nearer to this species than any other, but in this example the zooidal tubes are much more numerous and more closely set than in any other *Stromatoporella* ; in this respect it approaches closer to the true *Stromatopora*.

The bad preservation and the diverse appearance of sections not accurately cut render this species very difficult of description and identification. However after the examination of a number of sections one becomes accustomed to the general aspect and may recognize examples with facility. It is quite possible that this species is *Stromatopora galtensis* of Dawson.

Stromatoporella elora is one of the commonest forms of the Guelph dolomite and may be obtained at any of the well known localities.

STROMATOPORELLA ELORA, *var.* MINUTA, *var. nov.* Plate V, Figs. 2, 5, 6 ; Plate VI, Fig. 7

There are in the University collection a half-dozen of fragments which have caused me a great deal of uncertainty

as to their identity with *Stromatoporella elora*. The coenosteum cannot be described as to its external features, for only small fragments are available, but it seems to have been spreading in character and to have been bent into sharp folds. The thickness must have been at least 3 cm. but may have been much greater. Latilaminar structure is not very pronounced. The fibre and included calcite are of much the same colour so that the interpretation of thin sections is almost impossible. Well polished surfaces are much more satisfactory than thin sections.

The coenosteum is seen to be made up of a series of comparatively stout radial pillars which are connected at frequent intervals by delicate horizontal arms. These arms are somewhat flexuous, do not arise in whorls, and are very incompletely continuous so as to form laminae. Passing vertically through the coenosteum, in part between the horizontal arms, in part along the sides of the pillars and in part through the very centre of these elements are delicate zooidal tubes, apparently devoid of tabulae.

Vertical sections (Pl. V, Fig. 5) show the distinct vertical pillars, approximately parallel, and distant from each other about one-eighth of a millimetre so that four pillars and their interspaces appear in one mm. The connecting horizontal elements are much more frequent, as many as eight or ten occurring in the space of one mm. The horizontal elements, while not strictly formed into laminae, nevertheless show some regularity in arrangement, enough to justify the terms " laminae " and " interlaminar spaces." The vertical tubes are seen most frequently crowded into the side of the pillars, although some penetrate the coenosteum among the arms.

Tangential sections (Pl. V, Figs. 2, 6; Pl. VI, Fig. 7) if cut along an interlaminar space show more or less distinctly the cut ends of the pillars but in no case are they at all comparable in clearness of outline with the vertical section. Where

the pillars can be made out as distinct dots they are seen to be connected by very delicate arms suggesting the hexactinellid whorls of *Actinostroma.* Among these arms, in part bounded by them and in part squeezed into the sides of the pillars, are the minute tubes already referred to. In many parts of a tangential section the pillars are entirely obliterated by the invasion of these vertical tubules so that it presents a sort of fine net-like aspect. This appearance is due to the fact that the part of a pillar left by the occurrence of a tubule in its centre is of about the same calibre as the connecting arms.

Tangential sections which are at all thick, in fact all tangential sections thick enough to be of any value, do not show the fine connecting arms at all but present the typical appearance of *Stromatopora* (Pl. V, Fig. 6). On polished surfaces however the structure above described can be made out Astrorhizal systems of a delicate character throw a ramification of canals over the whole surface. The centres of these systems are about 4 mm. apart. A somewhat diagrammatic representation of a polished tangential surface is shown in Pl. V, Fig, 2.

This species presents affinities to *Actinostroma* in the distinctness of its pillars and in the lack of complete fusion of its horizontal elements. On the other hand it approaches *Stromatopora* in the character of the fibre and in the presence of zooidal tubes. It seems advisable to include this example with *Stromatoporella elora* and provisionally to give it the rank of a variety. The resemblance to *Stromatoporella elora* is so strong that at times I have been tempted to consider the differences as merely the result of different processes of fossilization. However the vertical pillars in the present variety are more prominent in vertical section. The tubules are smaller. The connecting bars are finer. The astrorhizal systems are smaller and less regular. In fact the whole coe-

nosteum is of a more delicate build except for the greater clearness of the vertical pillars. If the horizontal arms are at all thickened by secondary matter the resemblance to *Stromatoporella elora* is very strong, for the quadrangular interspaces become rounded and the pillars lose their outline as in *S. elora*. In this variety there is a strong suggestion of Bargatsky's genus *Parallelopora*. The vertical section particularly resembles *Parallelopora darlingtonensis*. The fibre does not present the vacuities characteristic of that genus, unless the minute vertical tubules are morphologically equivalent. *Stromatoporella elora minuta* is founded on six fragments from Durham collected by Mr. Joseph Townsend, of Toronto.

Family—IDIOSTROMIDAE, *Nich.*

Genus—HERMATOSTROMA, *Nich.*

HERMATOSTROMA GUELPHICA, *sp. nov.* Plate IV, Figs. 1, 2 ; Plate VI, Fig. 4

This species is founded on two very well preserved specimens, both from Elora. Neither of these examples is of sufficient size to render possible any account of the general surface characters or the size of the coenosteum. One specimen is three inches long by one and a half inch wide with a thickness of three-quarters of an inch. On the polished faces of this piece the pillars are seen to be parallel throughout and the horizontal elements to be destitute of curving ; from this it may be deduced that the coenosteum was of a considerable size and spreading rather than hemispheric in character. Latilaminar structure entirely absent.

The skeleton is composed of a series of parallel pillars of which about five occur in the space of one mm. The interspaces between the pillars are from one and a half to twice the thickness of the pillars themselves. The horizontal elements consist of rods of about the same calibre as the pillars,

forming with them an almost square network. These connecting structures are not disposed without regularity as in *Labechia* but are arranged, if not strictly, at least with a considerable degree of continuity into horizontal laminae. Both pillars and horizontal connecting elements appear to be hollow ; the internal canal is continuous in both the pillars and bars and is enlarged at the points of junction. Astrorhizal systems are entirely absent.

Vertical sections (Pl. IV, Fig. 1 ; Pl. VI, Fig. 4) show a distinct rectangular network in which the vertical components are much more continuous than the horizontal. Where the section passes through the centre of a pillar or bar the central cavity appears as a clear space, not filled with ferric oxide as in Nicholson's description of the type species of the genus *Hermatostroma.*

Tangential sections (Pl. IV, Fig. 2 ; Pl. VI, Fig. 3) present a different appearance according as the plane of section traverses a lamina or interlaminar space. In the former case the central hollow of the pillar is seen to be enlarged and to pass into the somewhat curved connecting processes. The various hollow bars with the cut ends of the pillars give to this part of a section the appearance of a mass of inosculating pipes. The interspaces probably represent the habitation cavities of the zooids. When the section follows an interlaminar space the cut ends of the pillars appear as small but very distinct rings. Astrorhizae are undoubtedly absent as neither vertical or horizontal sections show any trace of these structures.

This species appears to me to belong to Nicholson's genus *Hermatostroma.* The general structure of the coenosteum is identical, except for the absence of the " short flexuous tubes of considerable size, bounded by thin proper walls, and crossed by occasional tabulae." Although Nicholson thinks these structures to be part of the Stromatoporoid,

he discusses the possibility of their being of the nature of *Caunopora*. The net-like character of the coenosteum, and the existence of more or less distinct laminae removes the species from *Labechia*, even if the tubes are not really hollow. (It is always possible that this appearance is the result of mineralization.) It is certainly not to be placed under *Actinostroma* as there is no sign of the hexactinellid arrangement of the horizontal bars and the resulting angular network. If my conclusions are correct we have in this species the first recorded *Hermatostroma* in America and also the first in the Silurian. Out of a large collection only two specimens were found, both from Elora ; it may therefore be concluded that *Hermatostroma guelphica* is a rare form.

APPENDIX

It must be admitted as possible that other species occur in the Guelph dolomite, for numerous specimens were examined of which the structure could not be made out with sufficient accuracy for description. Notable is a compact close-grained example occurring in large (eight to ten inch) hemispheric masses and exhibiting distinct latilaminar structure with a fairly constant separation of about 8 mm. Another similar species but with the latilaminae much thinner may be referred to *Stromatopora antiqua*. Many sections were also examined in which faint evidence of laminae may be seen. These may belong to *C. striatellum* or some other species of *Clathrodictyon*. There also occurs a ramose form exhibiting slight evidence of the structure of a true *Stromatopora* but it is likewise much too poorly preserved to render a description justifiable.

EXPLANATION OF PLATES

Unless otherwise stated all figures are enlarged ten times

Plate I

Fig. 1—*Actinostroma vulcana.* Tangential section.
Fig. 2— " " Vertical section.
Fig. 3—*Clathrodictyon striatellum.* Tangential section.
Fig. 4— " " Vertical section.
Fig. 5—*Actinostroma vulcana.* Vertical section through one of volcano-like projections, showing the "crater" and "pipe,"x 2.
Fig. 6—*Clathrodictyon fastigiatum.* Vertical section.

Figures 1, 2 and 5 are from specimens presented by Dr. B. E. Walker.
Figures 3 and 4 from specimens collected by Mr. Joseph Townsend.
Figure 6 after Nicholson.

Plate II

Fig. 1—*Clathrodictyon ostiolatum.* Natural size.
Fig. 2— " " Vertical section.
Fig. 3—*Rosenella glenelgensis.* Vertical section.
Fig. 4—*Labechia durhamensis.* Vertical section.
Fig. 5— " " Tangential section.
Fig. 6— " " Tangential section of reversed specimen, showing the concretionary calcite surrounding the original position of the pillars and arms.

Figures 1 and 2 after Nicholson (Palæontology of the Province of Ontario.)
Figures 3 and 6 from specimens collected by Mr. Joseph Townsend.
Figures 4 and 5 from a specimen presented by Dr. B. E. Walker.

Plate III

Fig. 1—*Labechia durhamensis.* Vertical section of reversed specimen.
Fig. 2—*Labechia minora.* Vertical section of reversed specimen.
Fig. 3—*Stromatoporella elora.* Vertical section from polished surface.
Fig. 4—*Rosenella glenelgensis.* Vertical section. Natural size.
Fig. 5—*Labechia minora.* Tangential section of reversed specimen.
Fig. 6— " " " " " "

All figures from specimens collected by Mr. Joseph Townsend.

Plate IV

Fig. 1—*Hermatostroma guelphica.* Vertical section considerably restored.
Fig. 2—*Hermatostroma guelphica.* Tangential section. This section passes for the most part through an interlaminar space but the laminæ are cut at certain points.
Fig. 3—*Stromatopora guelphensis.* Vertical section.
Fig. 4— " " Tangential section.
(Compare Nicholson's figures of *S. concentrica*).

Fig. 5—*Stromatopora typica.* Tangential section.

Fig. 6—*Stromatopora constellata.* Tangential section.

Fig. 7—*Stromatopora typica.* Vertical section.

Fig. 8—*Stromatopora constellata.* Vertical section.

Figures 1, 2, 3 and 4 from specimens collected by Mr. Joseph Townsend.

Figures 6 and 8 from specimens from the Cobleskill, lent by Professor J. M. Clarke.

Figures 5 and 7 from a specimen identified by Nicholson in the Wenlock of England and presented by Dr. B. E. Walker.

PLATE V

Fig. 1—*Stromatoporella elora.* Vertical section.

Fig. 2—*Stromatoporella elora minuta.* Tangential section, somewhat diagrammatic, prepared from polished surface to show the connecting arms and the invasion of the pillars by tubules.

Fig. 3—*Stromatoporella elora.* Tangential section through a lamina.

Fig. 4— " " Tangential section passing largely through an interlaminar space.

Fig. 5—*Stromatoporella elora minuta.* Vertical section.

Fig. 6— " " " Tangential section.

Fig. 7—*Clathrodictyon ostiolatum.* Tangential section.

Fig. 8— " " Portion of surface. Natural size.

Figures 1-6 from specimens collected by Mr. Joseph Townsend.

Figures 7 and 8 after Nicholson (An. and Mag. Nat. Hist.)

PLATE VI

Fig. 1—*Labechia durhamensis.* Showing the vertical section partly polished and partly weathered, also the wrinkled concave epitheca, x ½.

Fig. 2—*Labechia durhamensis.* Tangential section showing the cut ends of the pillars, their hollow centres and the clear crystalline calcite sursounding them.

Fig. 3—*Hermatostroma guelphica.* Tangential section.

Fig. 4— " " Vertical section. The photograph does not show the hollow character of the pillars and horizontal elements.

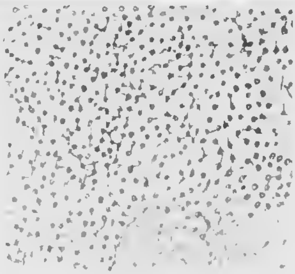
Fig. 5—*Rosenella glenelgensis.* Portion of surface of a plate showing its ridge-like character and less clearly the ramifications of the fine astrorhizal canals.

Fig. 6—*Stromatoporella elora.* Tangential section from polished surface.

Fig 7—*Stromatoporella elora minuta.* Tangential section from polished surface. On comparing this figure with Plate IV, Fig. 6, it will be observed that the latter figure, being prepared from a thin section, has lost many of the fine connecting arms. On the other hand the present figure has too fine an appearance owing to the photographic reproduction of matter not forming part of the coenosteum. Plate V, Fig. 2, is the mean of these two and although considerably restored and diagrammatic approaches most closely to the real structure of the coenosteum.

Fig. 8—*Clathrodictyon striatellum.* Tangential section.

All figures are produced from un-retouched photographs. Numbers 2, 3, 4 and 8 are from thin sections and numbers 1, 5, 6 and 7 from surfaces.



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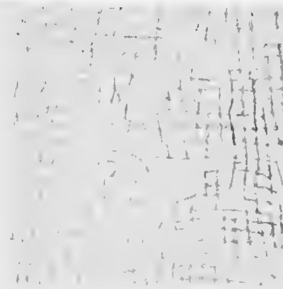

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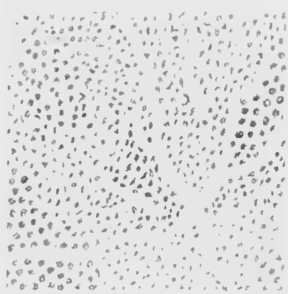

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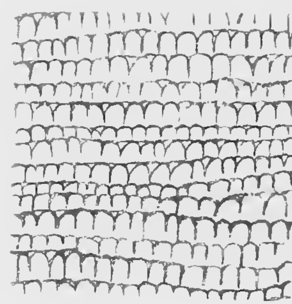

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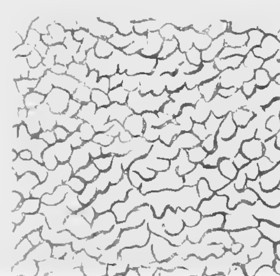

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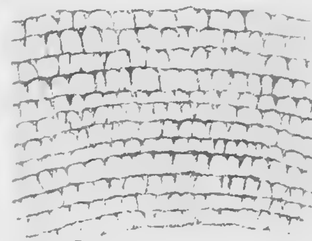

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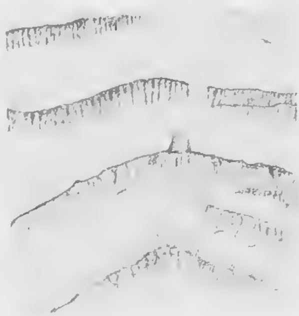

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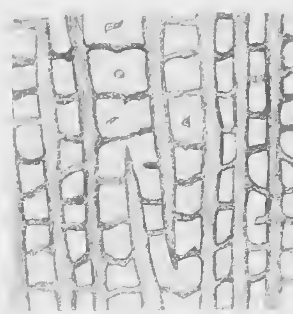

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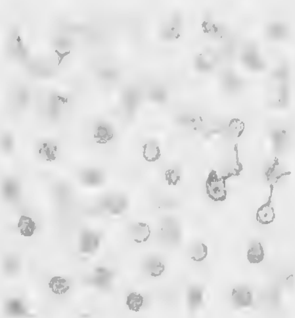

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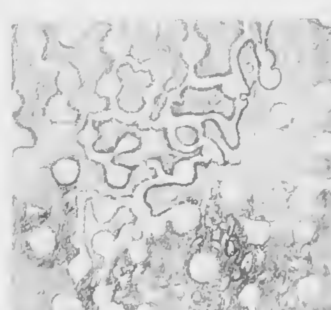

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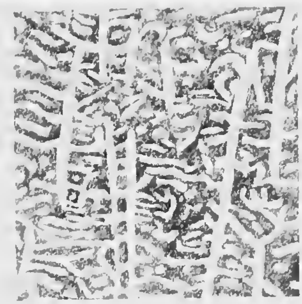

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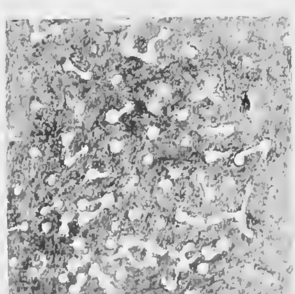

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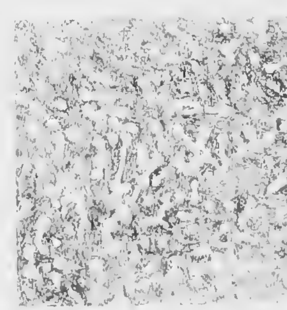

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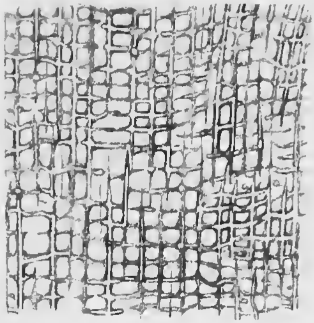

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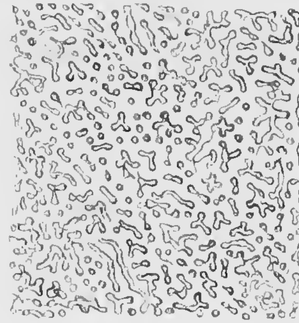

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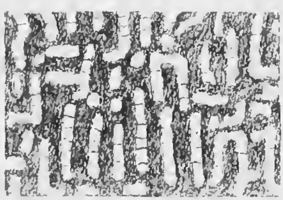

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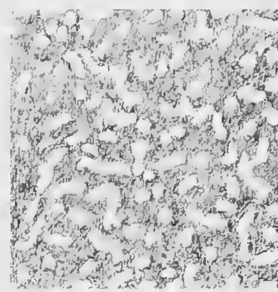

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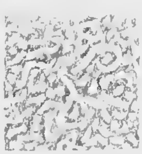

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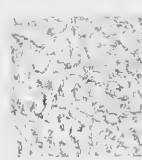

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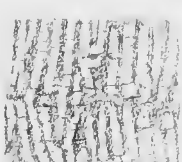

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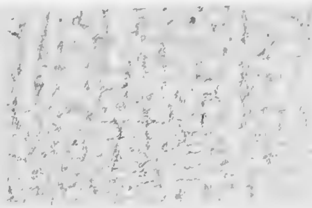

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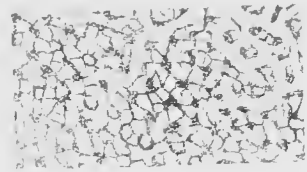

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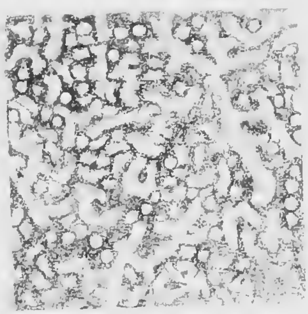

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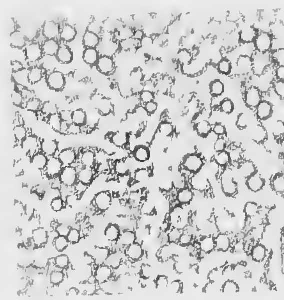

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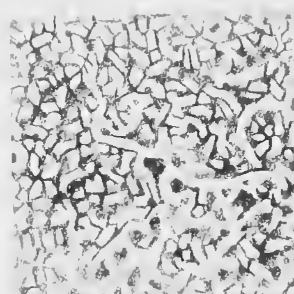

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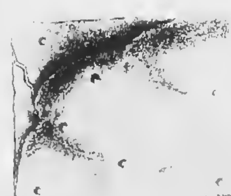

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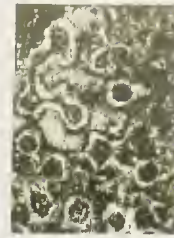

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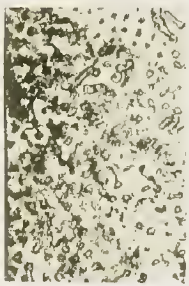

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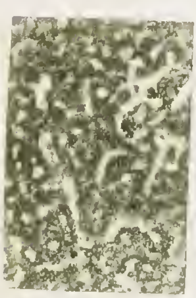

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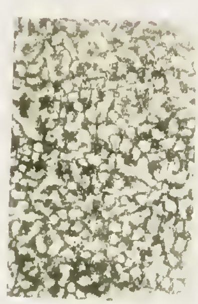

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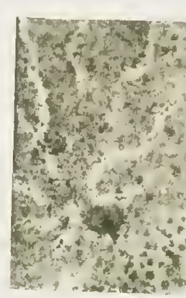

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